The Sidereal Messenger.

CONDUCTED BY WM. W. PAYNE,

Director of Carleton College Observatory.

MARCH, 1886.

CONTENTS:

By faith we understand that the worlds have been framed by the word of God, so that which is seen hath not been made out of things which do appear.

ARTICLES:— Page.

The Washington University Equatorial after the "Lick Pattern." Professor H S. PRITCHETT 65

Measures of the Velocity of Light from Astronomical Papers by Professor S. NEWCOMB 68

Return of Biela Meteors. E. E. BARNARD 74

Fluctuations of the Andromeda Nova. JOHN H. EADIE 79

Electric Phenomena in our Solar System. Professor JOHN HAYWOOD. (Illustrated) 81

Normal Solar Spectrum 87

EDITORIAL NOTES:—

The Double-Star Ceti 82 by S. W. BURNHAM and Mr. HERBERT SADLER of England.—Work at the Naval Observatory, Washington, 1886.—Mr Barnard's Independent Discovery of the Brook's Comet.—Double-Star 1968 by Mr. SADER.—Mr. Parkhurst's Observations of the Nova in Andromeda. (Illustrated).—Galle's Catalogue of Comets from 1860 to 1884.—Mr. Egbert's Elements of Comet Barnard.—Stellar Photometry at Harvard College Observatory.—Mr. Wendell's Orbit of Comet 1883 I.—Mr. Numsen's Observations of Mira Ceti.—Professor Swift's Last View of Comet (*a*) 1885 (Barnard).—Mr. Sadler's note on Double-Star H 2904.—List of Subscribers 87-94

BOOK NOTICES:—

Chamber's Hand-book of Descriptive Astronomy.—Chamber's Revision of Smyth's Cycle of Celestial Objects 94-96

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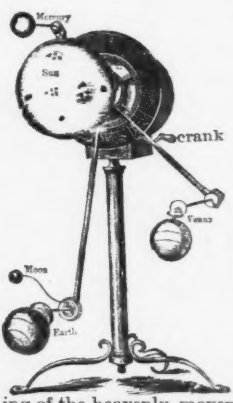

HELIOTELLUS

When the Earth's axis is pointed to the north, it will continue so pointing throughout the revolution, and will be in the Ecliptic. The Earth rolls over from west to east, and if the Equator be continued to the sky, it will meet the Equinoctial. So with the Ecliptic, if continued, it will come near to the Moon, near to Mercury, near to Venus, and always to the Sun.

I have now in my possession all the Heliotelluses for sale, made with a set of tools costing $25,000, which tools were afterwards destroyed by fire. They were so accurately made that the Heliotullus cannot now be duplicated for less than $250 each. The greatest impediment I find in their introduction is the Tellurian, which makes a false showing of the heavenly movements. It is a device in which the Earth's axis wabbles around the zenith and never points to the north. This is the greatest bearier to the comprehension of this most sublime of the sciences. The Heliotellus shows so near the truth that it is not hard to comprehend.

In high schools, seminaries, colleges, and all places of learning we find many globes and maps of the earth, but where can one be found having the Equator of the Earth so constructed that if continued it will meet the Equinoctial in the right place on the sky? Every child should have a truthful understanding of science. The Ecliptic should be correctly understood. All instruments which show imperfect teaching are hurtful; those which teach correctly are useful. The one should be rejected, the other sought for, and when found, should be prized even as a "pearl of great price." Three hundred such I now possess, all perfectly made, and I now propose to sell two hundred at the reduced price of $20 each, or for $65, the price of one, I will send four, each well packed in a strong box to carry by express anywhere.

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The Sidereal Messenger

CONDUCTED BY WM. W. PAYNE,

Director of Carleton College Observatory, Northfield, Minnesota.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 5. NO. 3. MARCH, 1886. WHOLE NO. 43.

THE WASHINGTON UNIVERSITY EQUATORIAL AFTER THE "LICK PATTERN."

H. S. PRITCHETT.*

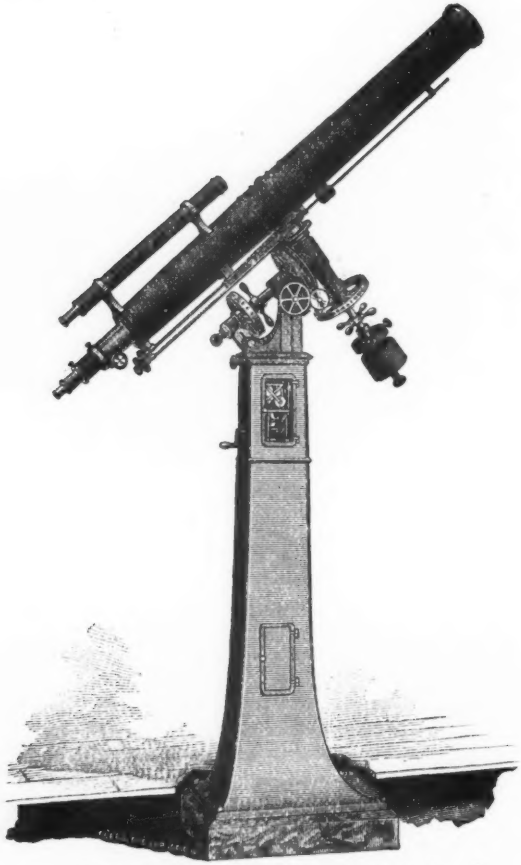
For the Messenger.

It has been frequently remarked that we shall never have the ideal telescope until an instrument-maker appears who shall first have been a practical astronomer. Whether this is true or not, it is certainly a fact that the aim of the telescope-makers has generally been directed toward the production of an instrument for looking, rather than for measuring. The practical astronomer desires an instrument which shall not only be optically perfect, but also that the instrument shall be easily controlled by the observer from the eye-piece, that the illumination should be capable of easy and quick adjustment,and that the circles can be read easily and quickly. In short, he desires a measuring machine capable of quick adjustment and easy handling. On the other hand, the maker of the telescope seldom makes a micrometer measurement and devotes his energies almost altogether toward perfecting the optical qualities of the glass. There are many telescopes of large aperture, in existence, at the present time, in which the facilities for handling the instrument are so poor, that micrometric work is difficult unless the astronomer is something of a mechanic.

A mounting for a 6-inch objective has recently been furnished by Messrs. WARNER & SWASEY, of Cleveland, Ohio, for the Observatory of Washington University, which seems to have solved some of the problems, which vex the observer, in

*Professor of Mathematics and Astronomy.

so satisfactory a way that a short description may not be uninteresting. The style of mounting was gotten up for the Lick Observatory, and for this reason has been termed by the makers the "Lick Pattern." The present mounting is the first made after this style.



Washington University Equatorial, St. Louis, Mo.

The accompanying cut shows at a glance the more promi-

nent features of the mounting. The following points will commend themselves to working astronomers.

(*a*) The instrument is adjustible for a large range in latitude. The inclination of the polar axis to the horizon can be changed by a rack and pinion without disturbing the base.

(*b*) The construction and place of the driving-clock form very interesting features in this pattern. The clock is an improved form of the conical pendulum regulator, and is placed within the cast iron pier where it is entirely out of the way and well protected from dust. The performance of the clock is practically perfect.

(*c*). The attachments for slow motion in Right Ascension and Declination (particularly in Right Ascension) are of an entirely new design, and form one of the strong points in the mounting. Two clamp rods may be seen in the cut extending from near the eye-end to the junction of the two axes. These rods are really double—each containing a smaller rod inside. One set serves for clamp and slow motion in Right Ascension, the other for clamp and slow motion in Declination. The inside rod in each case is the clamp. The small handles are for the clamps, the larger for the slow motion. The gearing by which the slow motion in Right Ascension is communicated to the polar axis, without interfering with the driving-clock, is exceedingly ingenious and effective. The attachment mentioned gives to the observer a complete control of the instrument by a rigid attachment which is always in place, and which cannot slip or interfere with the running of the driving-clock. There are many smaller conveniences, such as a coarse graduation on the outside of the circles, large and convenient focusing screws, handles for turning the instrument in each co-ordinate, which add greatly to the convenience of the observer.

It has been the aim of the makers (Messrs. WARNER & SWASEY) to furnish a mounting in which the observer from his position from the eye-end could completely control the instrument. It is not too much to say that in the "Lick Pattern" this object has been very excellently accomplished. In the important details of the driving-clock, slow motion in Right Ascension, convenience of the reading the circles and handling the telescope, this style of mounting leaves little to be desired.

MEASURES OF THE VELOCITY OF LIGHT.*

(*Continued from page 15.*)

At the time STRUVE'S result was published there was an apparent difference of one per cent. between its value and that of the light equation determined by DELAMBRE. The question then naturally arose whether the light equation, deduced on the hypothesis that the tangent of the angle of the constant of aberration was the ratio of the velocity of the *Earth* in its orbit to the velocity of light, might not need correction or modification. This question cannot yet be considered as definitely settled, since the modifications or corrections might arise from a variety of causes. One of these causes is connected with a very delicate question in the theory of the luminiferous medium; a question which can be most clearly understood when placed in the following form: It is a result of optical principles that a ray falling perpendicularly upon the bounding surface of a refracting medium retains its direction unaltered. Now, if this surface is carried along by the motion of the *Earth*, and the light comes from a star, and it is desired that this surface shall be so directed that there shall be no refraction, must it be placed perpendicular to the *true* direction of the star as freed from aberration, or to its *apparent* direction as affected by aberration? The difference of the two directions may exceed $20''$, and since the index of refraction of glass exceeds 1.5 there will be a difference of more than $10''$ in the direction of the refracted ray, according as we adopt one or the other hypothesis. Assuming that the standard direction would be perpendicular to the true or absolute direction of the star, it is easily shown that the constant of aberration determined in the usual way would be too large by a quantity depending on the ratio of the thickness of the objective to the focal length of the telescope. In an ordinary telescope the difference would be nearly one hundredth of the total value of the aberration, and would, therefore, closely correspond to the discrepancy between DELAMBRE'S result from the satellites of *Jupiter* and the modern determinations of the constant of aberration. The question of this particular cause

*Introduction to Parts III and IV of Vol. II of Astronomical Papers by Professor Simon Newcomb.

was set at rest by AIRY's experiments with a telescope filled with water, which showed that the result was independent of the thickness of the objective, and, therefore, that the apparent direction of the star was that on which refraction depended.

If, in accordance with the undulatory theory of light, we suppose the hypothetical entity called "the luminiferous medium" to be a substance, each part of which has its own definite and fixed location in space, then we must conceive that another unknown quantity may enter into the problem, namely, the motion of the heavenly bodies through this medium. We have relative motions in the solar system, exceeding fifty kilometers per second, and possibly greater relative motions among the stars. Now it is clear that the heavenly bodies cannot all be at rest relative to the medium, but must move through it with velocities at least of the order of fifty kilometers per second, and possibly greater without limit, since it is conceivable that the whole visible universe might be moving in a common direction relative to the medium.

It is easily seen that if we suppose the volocity of the *Earth*, through the medium, to have a small ratio, a, to the velocity of light, then the observed constant of aberration may be altered by an amount found by multiplying its value by a quantity of the order of magnitude of a. This alteration would be entirely insensible if the *Earth* does not move through the medium with any greater velocity than it does around the *Sun*, since the the value would then be only one ten-thousandth. It is remarkable that so far as yet investigated every optical effect arising from such a motion, which could be measured on the surface of the *Earth*, is of the order of magnitude of the square of a. Thus, no phenomenon has yet been discovered which can be traced to the motion in question.

Assuming that there is no general motion of the solar system through the ether of a higher order of magnitude than that of the relative motions of the fixed stars to each other, and that the ordinary theory of aberration is correct, there will be three constants between which a relation exists, such that when any two are found the third can be determined. These constants are:

1. The distance of the *Sun* in terrestrial units of measure;
2. The velocity of light in units of the same measure; and
3. The constant of aberration, or, which is supposed to be equivalent, the light equation.

Until our own time the first and third constants were used to determine the second. From the fact that light required about 500 seconds to traverse the distance from the *Sun* to the *Earth*, and that the distance of the *Sun* was, as supposed, 95,000,000 of miles, it was concluded that light moved 190,000 per second. The hopelessness of measuring such a velocity by any means at the command of physicists was such that we find no serious attempt in this direction between the date of the futile effort of the Florentine Academy, and that of the researches of WHEATSTONE, ARAGO, FIZEAU, and FOUCAULT nearly two centuries later. One of the most curious features presented by the history of the subject is that two entirely distinct methods, resting on different principles, were investigated, and put into operation almost simultaneously. The revolving mirror of WHEATSTONE, and its application to determine the duration of the electric spark and the velocity of electricity, come first in the order of time. But before this ingenious instrument had been applied to the actual measurement of the velocity of light, FIZEAU had invented his toothed wheel, by which the same object was attained.

FIZEAU'S paper on the subject was presented to the Academy of Sciences July 23, 1849.* We have already shown that his method and that of Galileo rest fundamentally upon the same principle. The arrangement of his apparatus was substantially as follows:

A telescope was fixed upon a house at Suresne pointing to the hill Montmartre. On this hill was a second fixed telescope looking directly into the first, the distance between them being about 8,633 meters. In the focus of this second telescope was fixed a small reflector, so that a beam of light from the first would be reflected directly back to it. By means of a transparent glass, fixed in the eye-piece at an angle of 45°, a beam of light was sent from the first telescope to the second, and, on its

* Comptes Rendus, vol. xxix, 1849, p. 90.

return through a total distance of seventeen kilometers, could be seen as a star by an eye looking through the first. Alongside the eye-piece of the latter a revolving wheel, with 720 teeth cut upon its circumference, was fixed in such a way that the beam of light both in going and coming had to pass between the teeth. When the wheel was set so that the tooth was in the focus, the beam would be entirely cut off in its passage through the telescope. Changing the position of the wheel through half the space between the middles of two consecutive teeth, the light would go and come freely between the teeth. When the wheel was set in revolution a succession of flashes would be sent out. If, on the return of each flash, a tooth was interposed, it would be invisible to the eye looking through the telescope. FIZEAU found that with a velocity of 12.6 turns per second each flash which went out was on its return cut off by the advancing tooth. With a velocity twice as great as this it was seen on its return through the opening next following that through which it went. With three times this velocity it was caught on the second tooth following, and so on.*

This experiment of FIZEAU was soon followed by the application of the revolving mirror of Sir CHARLES WHEATSTONE. Shortly after measuring the duration of the electric spark, this investigator called attention to the fact that the same system could be applied to determine the velocity of light, and especially to compare the velocities through air and through water. In 1838 the subject was taken up by ARAGO, who took pains to demonstrate that it was possible, by the use of the revolving mirror, to decide between the theory of emission and that of undulations by determining the relative velocities in air and in a refracting medium.†

The difficulties in the way of securing the necessary velocities of the mirror and of arranging the apparatus were such that ARAGO never personally succeeded in carrying out his ex-

* It is curious that the author's account of this remarkable experiment, which forms an epoch in the history of physical science, is contained within the limits of two pages, and terminates without any definite discussion of the results. It is merely stated that the result is 70,948 leagues of twenty-five to the degree, but the velocity, in kilometers, which must have been that first obtained, is not given, nor is it stated what length the degree was supposed to have in the computation.

† Comptes Rendus, 1838, vol. vii, p. 954; Œuvres de Francois Arago, vol. vii, p. 569.

periments. This seems to have been done almost simultaneously by FOUCAULT and FIZEAU about the beginning of 1850. Both experimenters seem to have proceeded substantially on the same principle and to have reached the same result, namely, that the motion of light through water was slower than through air in the inverse proportion of the indices of refraction of the two media.*

An important and most necessary modification of ARAGO's plan was made by these experimenters. As originally proposed, the plan proposed was to send an instantaneous flash of light through water and through the air and to receive it on the revolving mirror and determine the relative deviations in the positions of the images produced by the two rays. This system would, however, be inapplicable to the measurement of the actual time of transmission, owing to the impossibility of making any comparison between the time at which the flash was transmitted and that at which it was received on the mirror.

This circumstance would, indeed, have rendered the actual realization of ARAGO's project nearly impossible for the reason that the flashes of light, seen through the water, would have reached the mirror at every point of its revolution; and only an exceedingly small fraction of them could have been reflected to the eye of the observer.

This difficulty was speedily overcome by FOUCAULT and FIZEAU by a most ingenious arrangement, of equal importance with the revolving mirror itself. Instead of sending independent flashes of light to be reflected from the mirror, a contiuuous beam was first reflected from the revolving mirror itself to a fixed mirror, and returned from the fixed mirror back on its own path to the revolving one. A succession of flashes was thus emitted as it were from the fixed mirror, but their correspondence with a definite position of the revolving mirror was rendered perfect. Moreover, by this means, the image was rendered optically continuous, since a flash was sent through and back with every revolution of the mirror, and after the velocity of the latter exceeded thirty turns per second, the successive flashes presented themselves to the eye as a perfectly continuous image.

* Comptes Rendus, XXX, 1850, pages 551 and 771.

It was not until 1862 that this system was put into operation by FOUCAULT for the actual measurement of the velocity of light through the atmosphere. A new interest had in the mean time been added to the problem by the discovery that the long accepted value of the solar parallax was too small, and that the measurement of the velocity of light afforded a method of fixing the value of that constant. The central idea of the method adopted by FOUCAULT was that already applied in comparing velocities through different media. The element sought is made to depend upon the amount by which the revolving mirror rotates while a flash of light is passing from its surface to the distant reflector, and coming back again. As the details of FOUCAULT'S method will be best apprehended by a comparison of them with those adopted in the present investigation, a complete description of his apparatus will here be passed over. It may, however, be remarked, that what he sought to observe was not the simple deviation of a slit, but the deviation of the image of a reticule. The deviation actually measured was 0.7 millimeter, and the system adopted was to determine at what distance, with a definite velocity, this amount of deviation could be obtained. His result for the velocity of light was 298,000 kilometers per second.

The next measures of the element in question were those of CORNU. The method which he adopted was not that of the revolving mirror, but FIZEAU'S invention of the toothed wheel. His earlier measures, made in 1870, and communicated to the French Academy in 1871, led to a result nearly the same as that of FOUCAULT.* This result was, however, not so satisfactory that the author could record it as definitive. He, therefore, in 1874, repeated the determination on a much larger scale and with more perfect apparatus. The distance between the two stations was nearly twenty-three kilometers, and, therefore much greater than any before employed. He was thus enabled to follow the successive appearances and extinctions of the reflected image to the thirtieth order; that is, to make fifteen teeth of his wheel pass before a flash returned from the distant, and to have it stopped by the sixteenth tooth.

(To be Continued.)

*Comptes Rendus, vol. lxxiii, 1871, p. 857.

RETURN OF THE BIELA METEORS.

E. E. BARNARD.

Though I had the great misfortune to lose the opportunity of witnessing the maximum of the return of the BIELA meteors, the night of November 27, and from thence till December 2 being cloudy, yet observations on November 25 and 26 gave abundant proof of a large return of the shower of 1872. After a long, cloudy spell it cleared up on the night of November 25 for a short interval, and the frequency of bright meteors was quite noticeable. A careful observation on that night could not be made, as I was forced to divide my time between the meteors and the vain search for a reported comet, with a tail one degree and a half long.

NOVEMBER 25.

$5h$ $30m$, Nashville mean time, a third or fourth magnitude meteor in quite good twilight shot across the western part of *Pegasus*. Motion west, pretty rapid, color white. $6h$ $15m$, 4th magnitude, white, slow, appeared at $\alpha = 0h$ $20m$, $+27°$, slow path 5° or 6° long directly towards λ *Pegasi*.

$6h$ $50m$, 1st magnitude, white, not fast. Appeared $0h$ $15m$, $+25°$. Disappeared $23h$ $30m$, $+17\frac{1}{2}°$, place good. $7h$ $34m$, 4° southeast of λ *Pegasi* to $22h$ $15m$, $-11°$, of 1st magnitude, reddish, pretty rapid slender train for a moment. Ten minutes previous to the last observation saw three small meteors, two of them from *Andromeda*, motion southwest.

$7h$ $39m$, white, quick, 3rd magnitude. Appeared $20h$ $15m$, $+11°$. Disappeared $19h$ $15m$, $+9°$ like a flash of light. $7h$ $47m$, faint, 6th magnitude. Appeared $0h$ $0m$, $+21°$. Disappeared $23h$ $35m$, $+15°$.

Between $7h$ $47m$ and $7h$ $52m$, five small ones seen, the last at $7h$ $52m$, 4th magnitude, white, first appeared at $23h$ $55m$, $+11°$. Disappeared at $23h$ $45m$ $+3°$. $7h$ $58m$, two seen near same region, the brightest appeared at $21h$ $10m$ $+19°$. Disappeared at $20h$ $29m$, $+25\frac{1}{2}°$ at the point occupied by a 5th magnitude star.

$8h$ $19m$, 3rd magnitude, white, quick, appeared at $2h$ $55m$, +21°. Disappeared at $22h$ $25m$, +17°. The sky had become pretty well covered with haze and broken clouds here. The rest of the observations through gaps in the clouds. $8h$ $23m$, white, quick, 5th magnitude, path 4° long, passed 3° northwest of ε *Pegasi*, motion west slightly south.

$8h$ $40m$, white, very rapid, 5th magnitude. Appeared at $0h$ $30m$, +45°. Disappeared at $22h$ $0m$, +64° approximate place, $7h$ $45m$, 3rd magnitude, white, swift from α *Cygni* to $21h$ $55m$, +23°. Sky pretty well covered with clouds and the meteors seen here and there between the clouds. These paths are all taken from BURRITT'S Geography of the Heavens, which is engraved for the epoch 1840.0 so far as I can find out. As I have stated the number of meteors on the night of 25th can not fairly be judged from these observations for the reason assigned. As the night of the 26th promised to be clear, I determined to do nothing but watch for and record meteors. To my left, i. e., north, the dome of the equatorial obstructed part of the sky to about 15° above *Polaris*. My western sky could be seen possibly about 50° beyond the zenith. My view was unobstructed to the south, southeast, east, northeast. The following table gives the result of my observations until clouds prevented further watch. There are fifteen watches comprising a total watch, during which my eyes were not once removed from the sky, of $2h$ $22.5m$. The actual number of meteors counted was 285, but the number actually seen, including outside of the watches, would far exceed exceed 300. The following notes refer to the individual watches and refer to the corresponding numbers of watches as given in column six of the following table:

(1). All but one from the direction of *Andromeda*. Most near α *Andromedæ*, with short paths, these were faint. One, from *Andromeda*, in east motion northeast. One of the faint meteors passed over α *Andromedæ* and reached the 5th or 6th magnitude 5° south or west of α. The point of appearance was at α.

COUNTS OF METEORS ON NIGHT OF NOVEMBER 26TH, 1885.

From	Till	Interval	Number of meteors counted	Hourly rate	Number of counts
5h 47 m	6h 7m	0h 20 m	20	60	1
6 11.5	6 22	10.5	22	126	2
6 27	6 30	3	4	80	3
6 46	7 0	14	20	86	4
7 4	7 14	10	24	144	5
7 17	7 19	2	4	120	6
7 24	7 31	7	16	137	7
7 35	7 47	12	20	100	8
8 4	8 17	13	32	148	9
8 20	8 34	14	25	107	10
8 38.5	8 48	9·5	25	158	11
8 51	8 59	8	25	187	12
9 2	9 8.5	6.5	25	231	13
9 11	9 13	2	4	120	14
9 55	10 6	11	19	104	15
	Sums	2h 22.5m	285		

The nunbers refer to the individual watches.

(2). All from *Andromeda*. One went southeast, two went northeast, the rest nearly all west. Mostly small, several of 4th magnitude. Nearly all near *α Andromeda*. Hazed up now with dense smoke.

(3). All from *Andromeda*, the last one, at 6*h* 30*m*, nearly equal to 1st magnitude, stationary (not quite) at 10½° east of *β Andromedæ*, path about ½° long toward southwest. One seen just before this passed on the line from *α Andromedæ* to *α Pegasi* (*perfectly* on the line). It started about 2° from *α Andromedæ* toward *α Pegasi* and did not reach the latter star by 3°. This meteor was of 3rd magnitude, moderate motion. Dense smoke and wet haze now covered over the heavens. The meteors seem to come in groups. For a minute or so there will be perfect lull, then several would shoot out closely following each other. The meteors mostly white, none reddish. The ones with short paths, i. e., near *α Andromedæ*, were moving slow. They seemed to burn up and slowly increase in light. The sky has been fair till towards the last when smoke ond dense haze prevented observation.

All from *Andromeda*. Only one of these moving north-

east and the others westerly. Several of 3rd or 4th magnitude. In first part sky rather thick, but quickly cleared and sky good, but during most of the watch heavy smoke covered all the southern sky within 20° of *λ Pegasi.*

(5). All but one from *Andromeda.* This one was in the north and doubt if it was from *Andromeda.* Three seen in southeast, motion southeast, but from direction of *Andromeda.* Sky good, but at first smoke covered part of south sky.

(6). The last one at 7*h* 19*m*, passed directly from *β Andromedæ* towards *λ Pegasi.* Path 6° long, rapid, 4th magnitude, slight train.

(7). Only one not from *Andromeda.* It appeared away over to the northwest, motion *toward Andromeda.* At 7*h* 31*m* a double meteor shot from *Andromeda* towards northwest, passing west of *Cassiopea*, 4th and 5th magnitude, both white. A fine one seen at about middle of watch in southeast, low down near horizon, brighter than 1st magnitude, path short, white, from the direction of *Andromeda.*

(8). All from *Andromeda.* Most of them toward the west. Nearly all appeared west of Great Nebula, one or two in southeast. The radiant, from merely watching the meteors, and not from any reduction seems to be some 4° or 5° northeast of *β Andromedæ.* After this stopped to fill lamp.

(9). One moving westward from south of *Pegasus* was doubtless not an *Andromeda* meteor. Three seen moving southeast, one northeast. The others mostly west and northwest. Sky good, a double meteor seen during this watch.

(10). All from direction of *Andromeda.* Three in extreme southeast, one far south. Two in northeast, rest more or less westerly. Sky has been fine. Five or six of 3rd or 4th magnitude, all white. Great intervals of quiescence in the radiant in those two last counts, and indeed in all the counts. During this count for about one minute, fully half a dozen shot rapidly following each other, from the direction of *Andromeda*, in a

south and southwest direction, evidently a group traveling together.

(11). All but one from *Andromeda.* This one was very rapid and white from *Polaris* to south. Moments of quiescence as in previous counts. Majority of the meteors toward west. A couple of 4th magnitude, all rest small

(12). All from *Andromeda*, none specially bright, all white, mostly to west.

(13). Two not belonging to *Andromeda*..

(14). All from *Andromeda*, clouding in east, and *Moon* whitening east sky. Stopped to give a hurried search for the supposed comet before *Moon* rose. During this time meteors were frequent and a number passed through the telescope.

(15.) *Moon* up. Thick masses of haze and clouds here and there over the sky. This count was at a great disadvantage from the causes stated, and of course cannot be taken fairly to represent the hourly rate. Considering the clouds and *Moon* I think the number seen at this count shows handsomely for the meteors.

The majority of the meteors were seen to the westward of the Great Nebula, with motion toward the west. I have been careful to note any moving toward the north, northeast, south, southeast and south. Those not stated to move in one of those directions were moving in a westerly course.

The meteors of the 25th were generally larger, probably the larger particles of this meteoric swarm lie on the outside.

A very noticeable feature in the observations of the 26th was the grouping of the meteors; for a minute or so there would be a perfect cessation; then a rapid discharge of half a dozen or so would occur following one right after the other and in several instances two moving side by side.

I therefore conclude that there is a tendency to group together in these meteors while traveling through space. The majority of the meteors observed were small, a great many so faint that close attention was required to see them. The mete-

ors of this radiant are white. Every one seen was more or less white, save the large bright 1st magnitude, reddish meteor seen on the 25th.

VANDERBILT UNIVERSITY OBSERVATORY, Nashville, Tennessee, December 11, 1885.

FLUCTUATIONS OF THE ANDROMEDA NOVA.

JOHN H. EADIE.

The interesting account given by E. E. BARNARD in the December number of the SIDEREAL MESSENGER of the rapid fluctuations in the light of the new star in the *Andromeda* nebula, encourages me to mention some observations of my own, which seem to confirm those made by him.

During the month of September I observed this star on eighteen different evenings with $3\frac{1}{4}$ inches aperture, comparing it with other stars in the neighborhood. From my notes, made at the time I find on September 5, 10:53 p. m. "a good deal of unsteadiness"—in light of the star—"like flickering, but this is possibly due to wind blowing at the time."

Sept. 16, 8:45 p. m. "Curious undulations of light * * * so that the star seemed to disappear for an instant and then become steady for a moment, * * * probably atmospheric, but not noticed in neighboring stars. Sept. 20, 9:56 p. m. "There is a certain unsteadiness about the light of the nova, momentarily appearing dim and then brightening again. Different from neighboring stars." In October sometime after the star had got beyond the reach of my glass, I saw it again with the 9-inch refractor of HENRY M. PARKHURST in Brooklyn.

It was then faint and was a most tantalizing object to observe. It would be visible for a second or two, then suddenly disappear from view and so remain for a brief period when it would again become visible, only to go through the same changes as before—while other stars of nearly the same magnitude were

not apparently so affected. Mr. PARKHURST confirmed my observations in this respect.

I have been looking over GORE's Catalogue of known variable stars and I find in his note on the new star in *Corona*, in 1866, the remark that some observers noticed that the star twinkled much more perceptibly than others in the neighborhood, so much as to render comparisons at times difficult.

Rapid fluctuations have been seen in some of the nebulæ, such as the ring nebula in *Lyra*, as well as those mentioned in Mr. BARNARD's article above referred to.

Similar momentary changes have been, from time to time, noticed in the tails of comets. Rev. T. W. WEBB, in *Celestial Objects* says that "corruscations or flashings have been often remarked in the tail; that of 1556 was said to waver like the flames of a torch in the wind; and numerous other instances might be given, before and since the use of telescopes. The accurate HOOKER took many precautions before he satisfied himself of this reality in 1680 and 1682 and SCHROETER stoutly maintained their existence in 1807, referring them to electricity or some analagous cause; others negative them as too rapid for the progressive motion of the light by which we should see them,—an objection, applying only to fore-shortened tails.—and treat them as illusions depending on our own atmosphere, or the uncertainty of weary sight."

In an article in the October number of *The Observatory*, on the Pons-Brooks Comet, E. E. BARNARD speaks of a continued disturbance of the cometary light about one degree behind the nucleus, as observed by him, and he also says that at this distance back from the nucleus "there seemed to be a decided pulsation in the light of the comet; though the appearance was possibly imaginary,the body of the comet seemed rapidly to swell and contract, so that a small star close to it would seemingly be involved in the nebulous light and the next instant free of it. Nevertheless the definition was good and the phenonenon striking. In the great comet of 1882 I noticed on two or three

occasions a momentary extension of the tail, especially on its southerly side—or rather the matter comprising the tail near its extremity appeared to momentarily fluctuate in brightness. It is very probable that many other instances of this nature might be given by those having access to the necessary data, but I think those mentioned show a striking similarity in the action of the light of the different bodies referred to, and which differs greatly from that of the majority of the fixed stars and nebulæ.

What the cause of these rapid changes is I am not prepared to say. If these changes are real, they are suggestive of electrical origin. If they are only apparent and entirely due to the action of our atmosphere, it would be interesting to hear from those who are able to give a reason for so great an effect of the atmosphere upon the light of the particular objects above mentioned, while others of an apparently similar nature and often in same neighborhood were not at the same time so affected.

BAYONNE, N. J. December 6, 1885.

ELECTRIC PHENOMENA IN OUR SOLAR SYSTEM.

JOHN HAYWOOD.*

For the Sidereal Messenger.

I wish to state the probability of a relation between certain phenomena with a view to help to further observation.

The northern and southern aurora is pretty generally understood to be of an electrical nature. How is it caused? We notice, in the northern hemisphere, that these lights make their appearance in the colder part of the year, for the most part, and at night of course. They have a relation, by coincidence, or otherwise, to the position of the *Sun*. To those living north of the Tropic of Cancer, at the time of the winter solstice and at midnight, the *Sun* is nearer to the nadir point than at any other time of the year. In this latitude, about 40°

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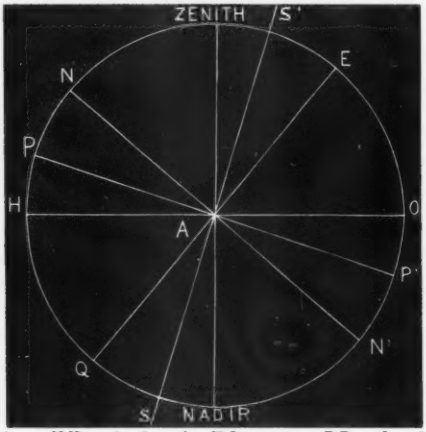
north, at that time the *Sun* is about $16\frac{1}{2}^\circ$ north of the nadir; and of course a line drawn from the *Sun* to the *Earth's* center and produced would intersect the upper meridian $16\frac{1}{2}^\circ$ south of the zenith. The angle made by this line with the horizon of this latitude at that time, varies through the night from 0° at sunset and sunrise to $73\frac{1}{2}^\circ$ at midnight.

Now if we conceive a radiant force in the solar rays, electrical and repulsive, there would be a flow of electricity from the side of the *Earth* next to the *Sun*, to the opposite hemisphere: that is in our case, before supposed, from near the nadir to near the zenith. This, under favorable circumstances, would be intense enough to be visible, and present all the appearances of the Aurora Borealis as it is seen by us; and seen still better in regions further north. This would be seen in the north because we are in the north ecliptic hemisphere; that is, the north pole of the ecliptic at that time is $73\frac{1}{2}^\circ$ north of our zenith; and the south pole is $106\frac{1}{2}^\circ$ south of the zenith. Therefore the electric flow along or near the *Earth's* surface in the south would be far below our horizon. *[diagram below.]* It is quite likely

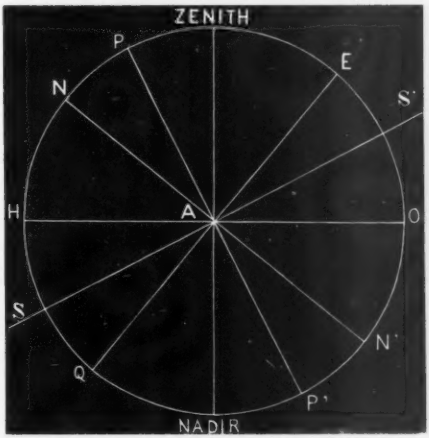


H O, horizon ; N N', axis of earth ; E Q, equator ; P P', poles of ecliptic ; S S', points in sun's path.

too that the display in the north is augmented by the favorable conditions of temperature.

Now conceive the terrestrial conditions in respect to electrical excitation to become sufficiently favorable. This electrical outflow may become intense and abundant enough to flow out into space in the direction of the radius vector, produced, and becomes a veritable tail if seen from the *Moon*, or some other planet.

On the other hand, at the time of the summer solstice, and at midnight, our situation would be quite different in respect to the *visibility of these lights. [diagram below.]* Now, the line



H O, horizon; N N', axis of earth; E Q, equator; P P', poles of ecliptic; S S', points in sun's path.

joining the *Sun* and the center of the *Earth*, produced, intersects the upper meridian 26½° above the southern horizon. The north pole of the ecliptic is now 26½° north of our zenith, and the south pole is 153½° south of the zenith; and the angle this radius vector makes with the horizon in this latitude, and at that time, varies between 0° at sunrise and sunset, and 26½° at midnight. These numbers, of course, are different for different latitudes. Now the auroral display, although in the higher regions of the atmosphere, and perhaps above it, would be below our horizon, commonly being manifested mostly in the hemisphere opposite to the *Sun* and well towards its center.

These electric phenomena I think to be a sort of secondary

result. The primary action of the *Sun's* electric force would be exerted upon the hemisphere facing the *Sun*, and with greatest intensity upon the portions where the *Sun's* rays are nearly vertical. The most conspicuous electrical phenomena are thunder storms. These we find occurring usually in the summer, and soon after midday, following the time when the *Sun's* rays are more nearly vertical, and therefore the solar radiation has the greatest intensity. It does not require a very great stretch of the imagination to conceive these thunderstorms to result from the direct action of the *Sun* upon the *Earth*; and more especially upon the atmosphere with its store of watery vapor. The electricity thus developed is driven by the same energy to the remoter hemisphere and dissipated in aurora when sufficiently intense; if less intense, quietly and invisibly. Perhaps the phenomena of heat lightning, seen in summer evenings, is due to this action; the electricity developed when the *Sun's* rays are most intense, scudding away to the opposite hemisphere: and in this case having sufficient intensity to be visible.

Therefore, admitting these explanations, thunder storms in the northern hemisphere would tend to a display of aurora at the antipodes in the southern hemisphere, and *vice versa*.

Also, it is not difficult to see a resemblance to the peculiar phenomena of the comæ and tails of comets. Granting a highly receptive quality to the physical nature of the comets, the radiant electric force of the *Sun*, which causes thunder storms and aurora on the *Earth*, may develope comæ and tails on comets. But there is a very wide chasm between the terrestrial aurora and the tails of comets. An additional link in the chain of evidence is needed, perhaps a number of them, to justify the conclusions arrived at so summarily. The auroral light, seen on the dark part of the *Moon's* disc near conjunction, assists somewhat in this difficulty. Reference is made to a note on this subject published in a former number of the SIDEREAL MESSENGER. Also the chief signal officer, Gen. HAZEN, kindly referred me to some foreign publications giving an account of observations of the same phenomenon. I have not access to these, but assuming that they verify the statement as to the

existence of these lights, they, to a certain extent, lend probability to the analogy suggested, and assist in bridging the chasm.

But there still remains the difficulty that an outflow of light, coresponding to the tail of a comet, has never been seen in the case of the *Earth* or *Moon*, or any other planet. It is not likely that an observer on the *Earth* can see such an outflow from the *Earth*. Even if there were an outflow of a number of thousand miles, it is doubtful if it could be seen as to its extent. There is more hope of successful observations of the *Moon*. Some observer, in some part of the world, may catch a view of the *Moon* at a happy moment, and see an auroral light extending sensibly away from the planet. Indeed, at the new *Moon* in January, the writer imagined he caught a glimpse of a faint, thin light extending upward from the *Moon* as it was setting behind a cloud. The time was about three days past conjunction. The appearance, however, was too faint and evanescent to do more than arouse a suspicion of its existence.

Perhaps some of the unexplained appearances at the time of a total solar eclipse may have some bearing on this case.

Still another possible test may happen in this way. In the event of an inferior conjunction of *Mercury* or *Venus*, occuring near the time of a total solar eclipse: since the illuminated hemisphere would be turned from the *Earth*, it would be invisible, unless made visible by an auroral light like that seen on the *Moon*. Further, if there were an outflow of electricity from the planet it might possibly be seen. This would go far to establish the character of the phenomena.

Perhaps in some such ways the phenomena of comets may be brought more nearly home to us.

NORMAL SOLAR SPECTRUM.

PROFESSOR H. A. ROWLAND.

This photographic map of the Solar Spectrum is now complete from wave length 3680. to 5790. and the portion above 3680. to the extremity of the ultra violet, wave length about

3100., is nearly ready. Negatives have also been prepared down to and including *B*, and it is possible they may be prepared for publication.

These photographs have been made with one of Professor ROWLAND'S concave gratings of 21½ ft. radius of curvature and 6 in. diameter, mounted so as to preserve the focus constant and give a normal spectrum of the same scale for any given spectrum. A scale of wave lengths has been added so that the whole makes a map of the spectrum, down to wave length 5790., more exact and giving greater detail than any other map now in existence. The error in the wave length at no part exceeds one fifty-thousandth of the whole, and is generally caused by a slight displacement of the scale which is easily corrected. The wave lenghts of more than 200 lines in the spectrum have been accurately determined to about one five hundred-thousandth part and these can serve as standards to correct any small error of the scale. It is to be noted, that the photograph of the spectrum can have none of the local irregularities of wave length, which occur in all engraved maps, and which amount to more than one twenty-thousandth part in all so far published. This often so distorts a group of lines as, in conjunction with the imperfect intensities, to render them almost unrecognizable.

The definition of the spectrum is more than equal in every part, down at least to wave length 5325., to any map so far published. The 1474 line is widely double, as also b_3 and b_4, while *E* is given so nearly double as to be recognized as such by all persons familar with spectrum observation. Above the green the superiority increases very quickly, so that at *H* we have 120 lines between *H* and *K* while the original negatives show 150 lines. The photographs show more at this point than the excellent map of LOCKYER of this region. Above *H* to wave lengths 3200. the number of lines in excess of all published maps is so great as to make all comparison useless. However, above *H* the determination of the wave length is more uncertain than in the visible parts, and must remain so until a special investigation can be made.

The plates all contain two strips of the spectrum, except No. 2, which contains three. They are three feet long and one foot wide.

Plate No. 1.	Wave length	3710. to 4185.	Scale	4	times	Angstrom.
2.	" "	3100. to 4135.	"	3	"	"
3.	" "	3680. to 3730.	"	3	"	"
4.	" "	4075. to 4530.	"	3	"	"
5.	" "	4480. to 4935.	"	3	"	"
6.	" "	4875. to 5325.	"	3	"	"
7.	" "	5210. to 5790.	"	2	"	"

These can now all be furnished to order except No. 2, the negative of which is being made.

The prints are made on heavy albumen paper carefully washed to prevent fading. The price has been put as low as possible. The set of seven plates, unmounted, $10; mounted on cloth, $12.00.—*From Johns Hopkins University Circular.*

EDITORIAL NOTES.

So much useful matter has been contributed to the MESSENGER during the last three months, that it has been quite impossible to present it all to our readers as promptly as might be expected.

THE DOUBLE STAR CETI 82.—Mr. SADLER, of England, well known to observers in the United States, calls attention to double-star *Ceti* 82. In Mr. BURNHAM'S seventh catalogue, its number is 395. From a notice in the *English Mechanic* (May 29 1885), the star is evidently a binary. At the time of its discovery Mr. BURNHAM estimated the position and distance of its components at 135°: 0.″5: 6.0, 6.0 magnitudes. According to Mr. SADLER'S statement, the pair has the large proper motion of 1″.355 annually in the direction of 91°, and its place for 1885 is $0^h\ 31^m\ 26^s$; −25° 24.′0.

DOUBLE-STAR 395. Under date of February 15, 1886, Mr. BURNHAM, of Chicago, says:

"A comparison of the observations first made of 395 (B. A. C. 160) with the measures of STONE (Cin. Obs.[6]) makes it certain that this is a physical system, if the large proper motion of 1.″436 in 90.°3, assigned by ARGELANDU, is correct. I do not know of any more recent measures. Unfortunately the race of double-star observers is rapidly becoming extinct, so far as the more difficult and interesting pairs are concerned."

WORK AT THE NAVAL OBSERVATORY FOR 1886.—By direction of GEORGE E. BELKNAP, Superintendent, the following programme of work, at the Naval Observatory will be pursued during the year 1886:

The Great Equatorial.—

1. Observations of a selected list of double-stars, such as have rapid orbital motions, or which present some other interesting peculiarity.
2. Observations of the satellites of *Saturn* and *Mars*.
3. Observations of some of the fainter stars in the *Pleiades*, to connect them with the bright ones recently measured with the Yale College heliometer.
4. Completion of the observations begun year before last for stellar parallax, and reduction of the same.
5. Reduction and discussion of all observations made with this instrument as rapidly as may be possible with the force available.

The Transit Instrument.—

1. Observations of the *Sun* daily.
2. Observations of the *Moon* through the whole lunation.
3. Fifteen to twenty observations of the major planets near opposition.
4. Five observations at least of each minor planet near opposition, when practicable.
5. Observations of the list of miscellaneous stars.

The 9.6-inch Equatorial.—

1. Observations of all the minor planets, whose brightness at opposition is greater than their mean brightness.
2. Observations of comets to determine position and physical peculiarities.
3. Observations of occultations of stars by the *Moon*, when of importance.
4. Observations of variable stars. [A photometer for this instrument has been ordered from Messrs. A. CLARK & SONS; a spectroscope by HILGER is ready for attachment].

The Prime Vertical Transit Instrument.—Observations of a selected list of stars, in conjunction with the Royal Observatory at Lisbon, whenever the latter Observatory shall assign a date to begin the work.

The Mural Circle.—This instrument will not be in use during the year, as the Repsold Meridian Circle at the Naval Academy at Anapolis has been kindly placed at the disposal of the Observatory by Captain F. M. Ramsay, for the purpose of carrying out the programme laid down for the Mural Circle last year. This programme is as follows:

Observations of stars down to the 7th magnitude,south of ten degrees north declination, the positions of which have not been recently determined at some northern observatory; the observing list to be formed of all stars from GOULD'S Uranometria Argentina visible here, and not found in YARNALL'S Catalogue, the Transit-Circle list of B. A C. stars,or

the recent Catalogue of the Glasgow University, together with the 303 zero stars for the continuation of the Southern Zones, and the 59 refraction stars contained in the programme of work in the Leiden Observatory. (*Vid.* Vierteljahrschrift des Ast. Ges. 1881.)

Time Service and Chronometers.—The time balls at Washington, New York, Philadelphia, Baltimore, Hampton Roads, Savannah and New Orleans will be dropped daily at noon of the 75th meridian; and the noon signals will be extended to such other places throughout the country as may be desirable, as rapidly as arrangements can be made.

The time-ball at San Francisco will be dropped daily at noon of the 120th meridian by signal from the branch Observatory at the Navy Yard, Mare Island.

A competitive trial of forty-three chronometers will be held; twelve to be purchased by the Bureau of Navigation.

The rating of chronometers on hand will be continued as heretofore.

Miscellaneous.—Photographs of the *Sun* will be taken daily, when practicable, with the photo-heliograph provided for photographing the Transit of *Venus*.

The examination of nautical instruments will continue.

Meteorological Observations will be made as usual.

THE BROOKS' COMET. On the evening of Dec. 27th, 1885, while seeking comets with my 5-inch refractor, I discovered a fairly bright comet some distance south of *Altair*. The comet was low and rapidly passing into dense haze near the horizon. I began a series of pointings upon it with 6-inch equatorial, securing five pointings before the comet finally disappeared in the haze. The resulting place of the comet derived from these observations was

$$\alpha = 19^h\ 55^m\ 25^s$$
$$\delta = +\ 4^\circ\ 5'$$

At Nashville M. T. $7^h\ 7^m\ 58^s$. No motion could be detected in the short interval that the comet was under observation. I at once announced the object to Prof. SWIFT, but the next morning (28th) received a telegram from him informing me that it had been found by Mr. W. R. BROOKS on the night of the 26th, thus, of course, giving the comet to Mr. BROOKS, to whom it justly belonged, though my discovery was entirely independent. The regular telegraphic announcement of this comet was not received here until the evening of Dec. 28th.

VANDERBILT UNIVERSITY, Jan. 15, 1886. E. E. BARNARD.

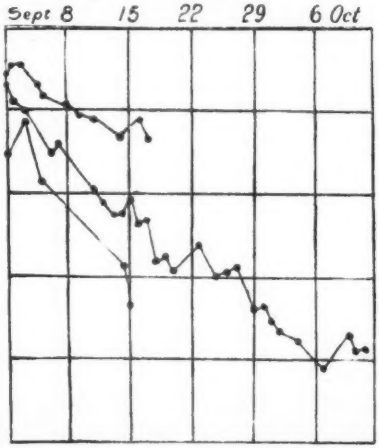
DOUBLE-STAR H, 1968. Mr. SADLER says: "There seems to be considerable change of the distance of H 1968, probably also from proper motion. HERSCHEL gives 61. 3:20″ ±, in his 5th catalogue, while Professor STONE at Cincinnati found 71. 9:7.″46 in 1879.

THE NOVA IN ANDROMEDA.—Having completed the reduction of my series of photometric observations of the nova with the aid of photometric determinations of the comparison stars kindly furnished to me by Prof. PICKERING, I send you the following table:—

Sept.	1	8.42	Sept.	14	9.89	Sept.	25	10.46	Oct.	9	11.21
	2	8.69		15	9.66		26	10.69		10	11.47
	4	8.67		16	9.78		27	10.71		11	11.36
	6	9.12		17	9.93		28	10.68		14	11.40
	7	9.10		18	10.18		29	10.89		15	11.57
	11	9.56		19	10.26		30	10.83		16	11.21
	12	9.79		26	10.50	Oct.	1	11.03		17	11.12
	13	9.94		23	10.24		4	21.29		18	11.53

Oct.	21	11.59	
	22	11.56	
	24	12.14	
	25	12.41	
	26	12.79	
	31	18.06	
Nov.	2	12.80	
	4	12.94	

I also send you the diagram I furnished to the *New York Herald*, up to October 12, giving my first approximation.



The diminution in brightness, measured in magnitudes, was nearly uniform, with the exception of three or four well marked waves, when the star grew brighter for a few days, and then recommenced its diminution. Had it returned to the former line, these waves might be supposed to be errors of observation; but each time, the new line, while parallel to the other, was nearly a magnitude brighter than the continuation of the old line. The crest of the first wave is shown at Sept. 15. The angularity during that week disappears in the final revision. The second crest is at Sept. 23, and the third at Oct. 17. The diagram shows on Oct. 7 a position by estimation which is omitted in the table. On Nov. 3 there appeared to be the crest of a fourth wave; but it was then too faint in my telescope to make this certain. The shorter lines in the diagram were derived from European observations. HENRY M. PARKHURST.

Galle's Catalogue of Comets from 1860 to 1884, as published in the *Astronomische Nachrichten* (Nos. 2665 and 2666) and translated from the German by W. C. WINLOCK, U. S. Naval Observatory, Washington, D. C., has already appeared in recent numbers of this journal. Besides the information contained in this catalogue concerning recent comets, generally, it is all important that American observers notice and adopt the natural, easy and exact mode of designating and cataloguing them which is used in this excellent paper. A few copies of the catalogue have been reprinted in pamphlet form, with care, which will be sent to any address on receipt of 50 cents for each copy.

COMET BARNARD.—The following elements and ephemeris were computed by H. V. EGBERT, assistant at Dudley Observatory, from the following positions determined by himself, except the first.

1885			R. A.	Decl.
Dec. 3	$11^h\ 11^m\ 09^s$	Nash. M. T.	$4^h\ 21^m\ 36.^s76$	$+4°\ 44'\ 13.''9$
12	8 58 00	Alb. M. T.	3 59 56.20	+5 34 16.9
25	6 22 14	Alb. M. T.	3 27 20.02	+7 14 09.5

ELEMENTS.

T = 1886, May 3.6513, Greenwich M. T.

$\omega = 119°\ 30.'1$
$\Omega = 68\ 15.5$ } 1886.0
$i = 84\ 44.1$

$\log. q = 9.68293$

Motion direct.

STELLAR PHOTOGRAPHY.—In the last annual report of Harvard College Astronomical Observatory information concerning important work in stellar photography appears. A lens of eight inches aperture, and forty-four inches focus, has been mounted equatorially and provided with a driving-clock. The work done by this instrument is various. When the clock is detached, trails of stars are taken due to the motion of the telescope; an equatorial star leaving a mark no brighter than sixth magnitude. Stars as faint as the fourteenth magnitude have been photographed without the clock-work. In this way the positions of faint polar stars may be determined with great accurracy. This means is also used to determine the measure of stellar brightness, and to form star-charts as large as the scale of PETERS and CHARCORNAC. But the most striking results have been obtained in photographing stellar spectra, which have been secured from stars of the eighth magnitude, in which lines are shown in a paper positive, sufficiently distinct to be clearly seen.

COMET 1883 I. (BROOKS). In a recent private letter from Assistant O. C. WENDELL, Harvard College Observatory, we have the following important facts concerning the orbit of the BROOKS' comet of 1883.

BRYANT'S orbit (Table of Elements January MESSENGER is based on these single observations, with an interval between the extreme ones of forty days. His orbit is a parabola and satisfies the middle place as follows—

$$O-C$$

$$\Delta\lambda' \cos\beta = +34.''1 \qquad \Delta\beta = +74.''0$$

The orbits which Mr. WENDELL has computed are all based on forty-one observations, combined into three normal places, and including between the extreme normals an interval of forty-one days. He calculated first a parabola, satisfying the middle place within about 4′ of longitude and 1′ of latitude. To reduce these residuals still farther, he calculated a second parabola, but the values came out almost identically with the first. So that the parabola did not completely satisfy the data.

Then he computed a final elliptic orbit with the following results:

$T = 1883$, Feb. $18^d\ 22^h\ 45^m\ 56^s$ (Paris M. T.)
$\pi = 29°\ 1'\ 58.''3$
$\Omega = 278\ \ 8\ \ 36.\ 3$
$i = 78\ \ 4\ \ \ 4.\ 9$
$\log. q = 9.8807707$
$\log. e = 9.9996026$

Motion direct.

Middle Place $(O-C)$	
$\Delta\lambda' \cos\beta$	$\Delta\beta$
+0.″05	+0.″03

These useful data will be given in the MESSENGER'S reprint of GALLE'S Catalogue of Comets, as they were kindly furnished by Mr. WENDELL for that purpose.

MIRA CETI. This wonderful variable star when brightest ranges between a second and a fourth magnitude; it then gradually declines, and after 74 days it becomes invisible to the naked eye, and so continues for five or six months. Its mean period from minimum to minimum is about 333 days. In the *Companion* to the *Observatory* (English) the maximum for 1886 is set down for Feb. 13. We notice that the *Astronom. Gesallschaft*, 1885, predicts two maxima for 1886, occurring respectfully Jan. 7 and Dec. 5.

W. H. NUMSEN, Baltimore, has been observing this star since Dec. 11, 1885, and he says the maximum seems to have occurred between the beginning and middle of last January. He is undoubtedly right.

It is also noteworthy that the RADCLIFFE observations of magnitude of the nova of *Andromeda* contain some of the same reference stars which were used by Mr. NUMSEN, as seems evident from a comparison of the diagram in the December *Monthly Notices* with those published in the MESSENGER.

COMET (*a*) 1885 (BARNARD).—*Who saw it last?* My last view of this comet was obtained on the evening of September 2. As I have noticed no published account of its having been seen later, and as I remember how excessively faint it was, and the prolongd and desperate effort it required to obtain, if possible, one more observation of it, I am naturally anxious to know if it was seen at a later date. Prof. EGBERT'S excellent ephemeris terminated on that day, so, setting the telescope with great exactness for it, starting the driving-clock, and using the periscopic comet eye-piece—power 132, field 32′—and with the seeing of the best, indeed, unequalled in clearness by any night spent in this observatory, I placed my eye, with well expanded pupil to the glass. A careful search showed only some very faint stars, none bright enough to at all interfere with the visibility of the comet. As I persistently gazed, more faint stars revealed themselves and inspired me with hope. At length, after a search of fifteen long minutes, the comet was detected, almost exactly in the center of the field. In all my experience in comet-seeking and in nebula work, I am sure I have never observed an object so faint, or one which required so prolonged an effort to see.

On the same night—Sept. 2—as I was returning from town, whither I had been to telegraph Prof. PICKERING of BROOKS' discovery of a comet, I, from a dark street, saw with perfect distinctness, with the naked eye, the nova in the *Andromeda* nebula. This plainly indicates the purity of the atmosphere on that occasion. The next evening, although a fine one, and though, through the telescope, the star appeared of equal brightness, yet I was unable to see it with the unassisted eye. LEWIS SWIFT.

WARNER OBSERVATORY, February, 1886.

THE DOUBLE-STAR, H, 2904. In a private letter, under date of January 28, 1886, HERBERT SADLER, of the Royal Astronomical Society, calls attention to the pair H, 2904, and says he does not think it at all probable that the pair is a binary one. Sir J. HERSCHEL'S distances of the double-stars, observed with his 20-feet reflector, in sweeping for nebulæ, are, as might be supposed, much underestimated as a rule. He further says:—

"A proper motion of 0.″437 per annum, in the direction of 197° on the part of the large star, will account for the observed movement. This would give 33.″0 for Sir J. HERSCHEL'S distance in 1834.60; the observation in his fifth catalogue was made, as I find on consulting his MSS, in 1830.62. In 1890 the position angle will be 125°.5, and the distance 15.″6, and about the year 1912 the small star will be on the parallel at 15.″5 distance. The large star was only nightly observed by LA CAILLE."

The following orders have not been previously acknowledged:

H. S. Pritchett, Washington University Observatory, St. Louis, Mo. John Goldie, Galt, Ontario, Canada. George Gildersleve, 43 Charles St.

Baltimore. John R. Hooper, Box 196, Baltimore, Md. Geo. R. Vickers, No. 9 German St., Baltimore, Md. Charles S. Rockwell, Tarrytown, N. Y. Royal Observatory, Greenwich, England. Observatory of the Cape of Good Hope, Capetown, South Africa. Wm. B. Phelps, Fargo, D. T. (Vol. 3). J. W. Thompson, Salem, Ohio. F. G. Blinn, East Oakland, California. Daniel Appel, 11 Irving St., Cleveland, Ohio. S. Wilson Fisher, 1502 Pine St., Philadelphia, Pa. John H. Eadie, Bayonne, N. J. Public Library, Chicago, 2 copies, 1886. Professor H. A. Howe, University Denver, Colorado. John W. Osgood, Cincinnatus, N. Y. John O. Williams, Bevier, Macon, Mo. Cincinnati Observatory, Mt. Lookout, Hamilton Co., Ohio. Professor John Haywood, Otterbein University, Westerville, Ohio. Prof. H. M. Perkins, Delaware, Ohio. G. D. Hulett, Oswego, N. Y. Henry M. Parkhurst, 25 Chambers St., Brooklyn N. Y. Professor Geo. B. Merriman, New Brunswick, N. J. Professor Wm. A. Rogers, Harvard College Observatory. Professor M. R. Conable, 1126 Girard St., Philadelphia, Pa. J. J. Gilbert, U. S. Coast and Geodetic Survey, Olympia, W. T. J. D. Devor, Elkhart, Ind. John Tatlock. The Literary Dept. Mutual Life Insurance Co., New York City. William Evans, 252 South Front St., Philadelphia, Pa. William C. Pond,719 Asylum Ave., Hartford, Conn. Messrs. Andr. Fred, Host and Sohn, Booksellers, Copenhagen, Denmark. Kaiserl, Univesitats Sterwarte, Kasan, Russia. William Strong, Kalamazoo, Michigan. Miss Anna Winlock, Cambridge, Mass. Professor C. S. Howe, Akron, Ohio. Mechanics Institute, San Francisco, California. Lewis H. Roberts, Clinton, Iowa. Mr. Perrotin, Directeur de l'Observatoire, Nice, Alpes Maritimes, France. University of Minnesota, Minneapolis, Minn. Library U. S. Naval Observatory, Washington, D. C. Lick Observatory, San Jose, P. O. California. Prof. J. T. Anderson, Fayette, Mo. Bert Luty, Allegheny, Pa. Public Library of Cincinnati, Cincinnati, Ohio. R. R. Beard, Pella. Ia. B. G. Way, 111 Fulton St., Brooklyn, N. Y. Arthur C. Perry, 261 Broadway, New York City. Wellesley Coll. R. R. Wellesley, Mass. Prof. Winslow Upton,Providence,R. I. University Reading Room,Eugene City, Oregon. James Jackson, Paterson, N. J. W. A. Kelso, 827 S. 18th St., St Louis,Mo. Albion College Library, Aibion, Mich. Library of McKim Observatory, De Pauw University, Greencastle, Ind. E. Crocker, Berea, Ohio, Chester Guild, 88 Summer St., Boston, Mass. J. Stahn, 13 Ensor St., Baltimore, Md. Chicago Public Library, Chicago, Ills.

A Hand Book of Descriptive Astronomy. By GEORGE F. CHAMBERS, F. R. A. S. Third Edition, Oxford, (England) 1877. pp. 928.

Through the kindness of the author, a copy of the third and last edition of this invaluable work has been placed on our book-table. It is

not a new book; neither is it one with which the experienced astronomer or observer is unacquainted either in this country or in any other. Attention is called to it now chiefly because of inquiries so often, from students and readers of popular astronomy to recommend some standard work, as a reference book which is accurate in detail, and one which contains most of the results of recent important astronomical research. In these particulars this book has no equal in the English language. Others are more full and specific in special lines of study; but, as a hand-book for the working astronomer, or as a text-book in descriptive astronomy for the student this work is unquestionably the best.

For those who have not seen the book, it may be well to add, that the text is free from the language, technical terms and symbols so much employed in practical astronomy dependent on the higher mathematics. The print is good, illustrations abundant, citations of authority very full, judgment on varying points of opinion of astronomers, when expressed, fair and candid, and the necessary tabular data are generously full and conveniently arranged, considering the interests of all for whom the book is designed.

A Cycle of Celestial Objects, observed, reduced and discussed by Admiral WILLIAM HENRY SMYTH, R. N., K. S. F., D. C. L. Revised, condensed and greatly enlarged by GEORGE F. CHAMBERS, F. R. A. S. Second Edition, Oxford, (England) 1881. pp. 696.

This book is not as well known in America as the one above referred to. The circumstances attending the appearance of the second edition are these: Admiral SMYTH'S original *Cycle of Celestial Objects* was published, in two volumes, in 1844. Though it was widely and favorably received, the first edition passed out of print in a few years, and a second was not prepared during the long and distinguished life of its author. This work, however, was entrusted to another, by the name of ISAAC FLETCHER, who doubtless would have done it well, but for the greater attractions of a political career open to him, which so hindered and delayed the revision, that he came to his death, in 1877, without doing very much to accomplish the important task. The original author's relatives and immediate friends then charged Mr. CHAMBERS with the serious responsibility of publishing the new edition of the book. All the materials which had been gathered by Admiral SMYTH during his long life, and those by Mr. FLETCHER during 32 years, came into Mr. CHAMBERS' hands in 1879, who immediately undertook the revision and completed it in the space of two years.

The aim before the present author was, to revise, prune and amplify

Admiral SMYTH's Bedford Catalogue, so as to provide a telescopist's manual for refractors to eight inches of aperture, and to bring its astronomy down to the year 1880, just as the original edition was useful for glasses of 5 inches aperture, to 1845.

Of the revision of Bedford Catalogue there was urgent need, in view of the seriously erroneus measures of an important class of double-stars. Attention was first called to this by Mr. BURNHAM of Chicago; a few years later, and in 1879, by Mr. SADLER of England, in a communication to the *Monthly Notices* of the Royal Astronomical Society brought the matter again to public notice, after which Mr. BURNHAM made a critical examination of the catalogue, and the result of his labors was given in an article of thirty-five pages in No. 8, Vol. 40, of the *Monthly Notices*, all but six of which were devoted to the measures of double-stars made by himself and other observers of recognized ability in comparison with the measures of Admiral SMYTH's Catalogue. This was indeed, timely work on the paat of Mr. BURNHAM, which naturally and irresistably found its proper place in the revision of the *Cycle*. And the author has very appropriately recognized the services of Mr. BURNHAM in the preface to the second edition, as follows: "Mr. BURNHAM has not only furnished me with an almost inexhausible supply of double star measures of great precision and late date, but has read all the proof sheets and made innumerable suggestions. Of these some are being treasured up for a future edition, having come to hand too late for use in this one.

These facts indicate something of the skill and labor that have been expended in bringing out this revision and they are certainly reasonable grounds of confidence for it in addition to the recognized authority of the reviser.

The *Cycle* contains 1604 celestial objects, arranged in the order of Right Ascension, giving the number of the star, the constellation, reference numbers in other important catalogues, declination, precession, double-star measures by all prominent observers, position angle, distance and epoch, and such additional historical notes and comments as may serve to make knowledge of them as complete as possible. The running head line at the top of each right hand page gives the first and last right ascensions of the two pages open to the eye at once, which is an exceedingly convenient arrangement to aid in finding particular objects, scattered through 680 pages. At the close of the volume is an analytical index which presents the entire list of celestial objects by constellations. This book is also heartily commended to the readers of the MESSENGER.

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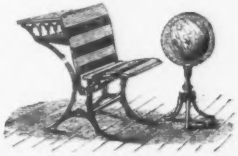

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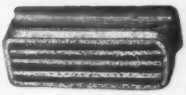

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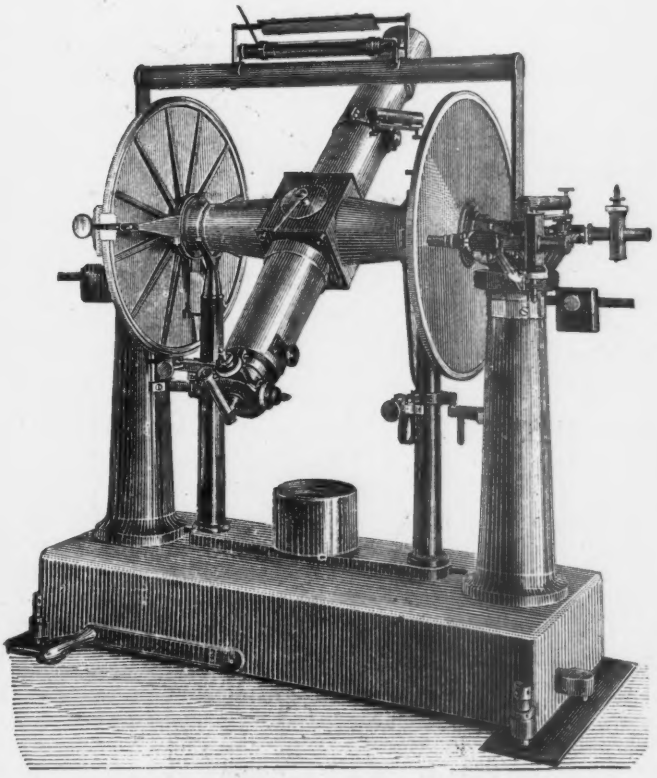

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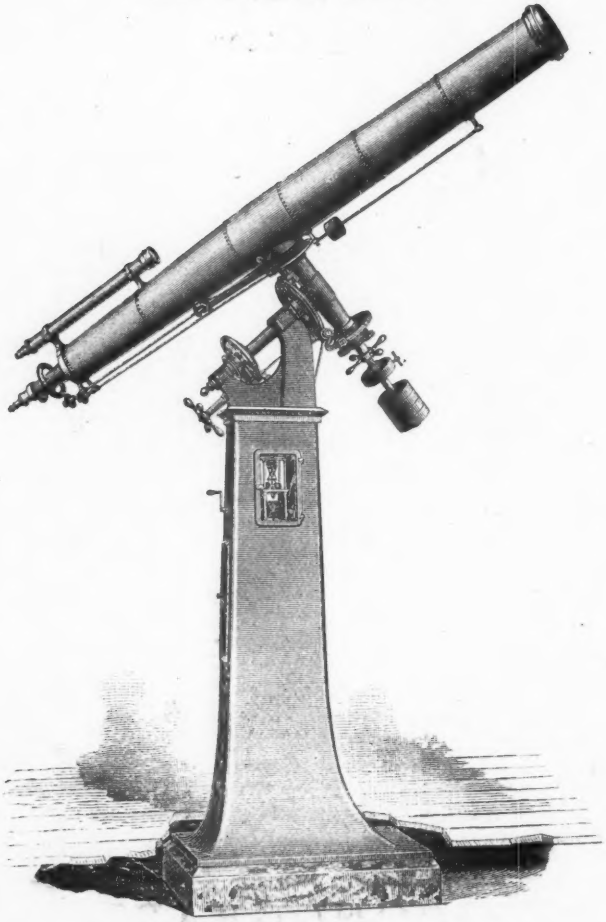

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